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Analysis Report for AP-070

Analysis of the H-11b4R Pumping Test Conducted From 6/11/12 to 6/14/12

AP-070: Analysis Plan for Hydraulic-Test Interpretations

Task Number 1.4.2.3

Authors: Michael Schuhen for Dale Bowman — 9/17/13
Dale O. Bowman, II — Date
HydroResolutions LLC

Technical Review: [signature] — 9/17/13
Kris Kuhlman, 6212 — Date
Sandia National Laboratories

QA Review: Shelly R. Nielsen — 9/17/13
Shelly Nielsen, 6210 — Date
S. M. Stoller Corporation

Management Review: [signature] — 9/17/13
Christi Leigh, 6212 — Date
Manager, Repository Performance Department

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1. Introduction

This report discusses the analyses of hydraulic tests performed in the Culebra Member of the Rustler Formation (Figure 1) at the Waste Isolation Pilot Plant (WIPP) site at the H-11 well pad. These analyses were performed in accordance with the Sandia National Laboratories (SNL) Analysis Plan for Hydraulic-Test Interpretations, AP-070, Revision 2 (Beauheim, 2009). The computer code used for analysis was nSIGHTS (n-dimensional Statistical Inverse Graphical Hydraulic Test Simulator), version 2.41a. A detailed description of the approach followed in these analyses can be found in Beauheim et al. (1993, Appendix B) and Roberts et al. (1999, Chapter 6).

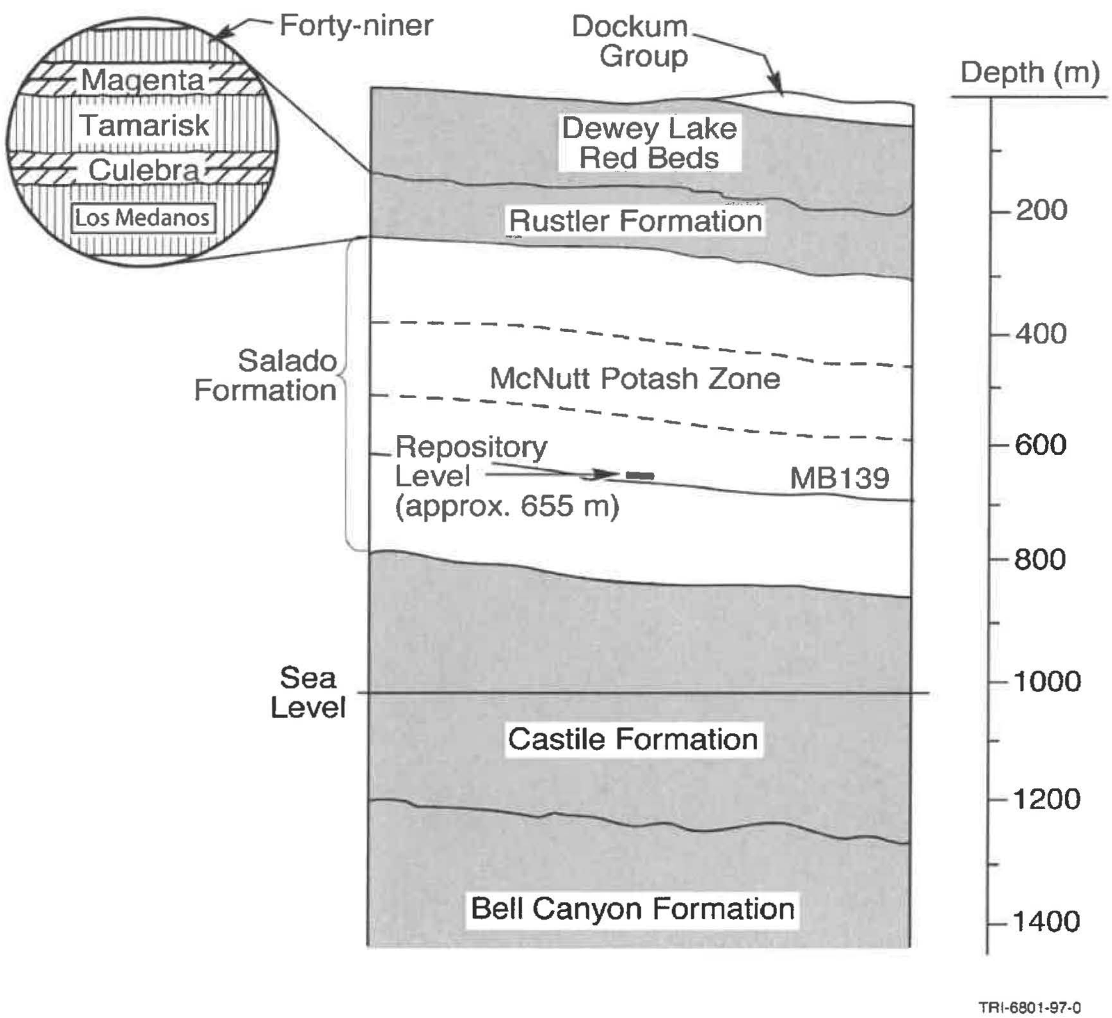


Figure 1. WIPP stratigraphy.

2. Test and Analysis Procedures

Three constant rate pumping tests were performed in the H-11b4R replacement well in 2012. The first two tests were purge tests performed to develop the well and obtain water samples for chemical analysis. These two purge tests used pumping rates of 10 gallons per minute (gpm) for approximately 5 hours and 12 gpm for approximately 4 hours. The third constant rate test used a pumping rate of approximately 12 gpm for 72 hours. The location of the H-11 wellpad in the WIPP well network is shown in Figure 2. Pumping test analyses included the fitting of Cartesian pressure data, pressure change, and pressure derivative (log-log diagnostic) as described by Bourdet (1989).

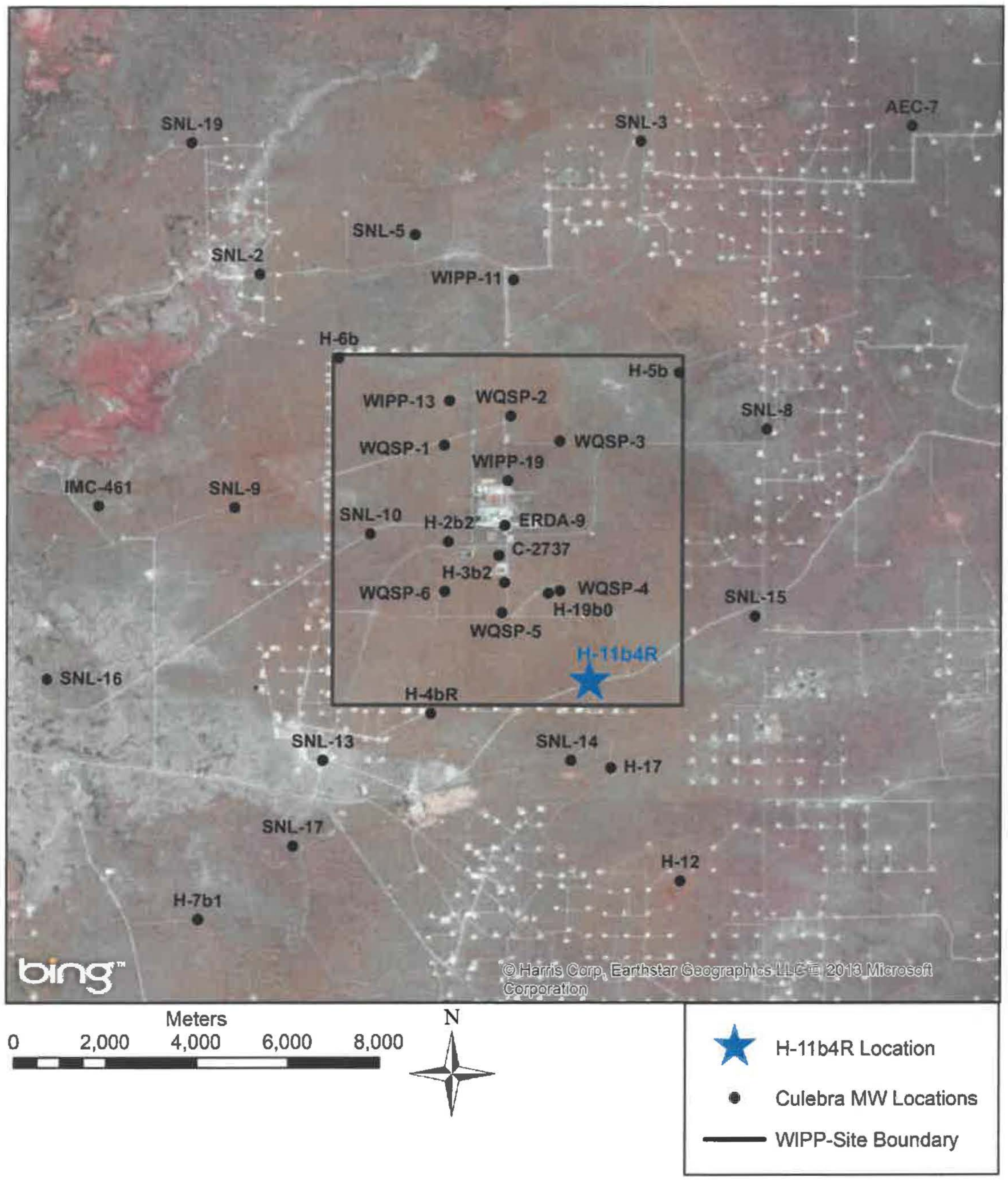


Figure 2. Location of the H-11b wellpad, which includes H-11b2 (Magenta) and H-11b4R (Culebra).

All the nSIGHTS test simulations incorporated pre-test pressure records of various durations as "history" periods where the associated pressures were simply specified in the simulations.

Test analysis involved finding the values of the fitting parameters that produced the best-simulated matches to the pressure data collected during the constant-rate test and subsequent recovery period. In addition to the formation properties of interest (principally transmissivity (*T*)), tubing string radius was also included as a fitting parameter in the pumping-test analyses so that nSIGHTS could exactly match the amount of wellbore storage observed during the test. The main objective of this analysis is to estimate *T* for subsequent use in *T*-field generation and WIPP performance assessment calculations, and to validate the construction of the replacement well against analyses conducted on data from previous Culebra wells on the H-11 wellpad. Correlation between estimated *T* values and the other fitting parameters reported in Appendix B would be of interest if these correlations resulted in large uncertainty in the estimated *T* values. The uncertainty in the estimated *T* values, however, is relatively small, so any correlation between *T* and other fitting parameters is not of concern.

The uncertainty quantification method applied to the analyses in this report is a process referred to as *perturbation analysis*. In this process, preliminary analyses are performed in which a reasonable fit is obtained to the specified constraints defined in the nPre configuration file. The resulting values of the fitting parameters are the *baseline solution* set – a single value for each fitting parameter that provides a satisfactory fit to the data (*satisfactory* being a judgment call on the part of the analyst). Perturbation analysis begins by assigning a plus/minus range corresponding to the parameter space one wishes to investigate to each of the baseline fitting-parameter values. These plus/minus fitting-parameter ranges for each analysis are listed in Appendix B. Starting at the baseline value, the fitting parameters are randomly perturbed to fall somewhere within their assigned ranges and are then optimized from these random starting points. The objective of perturbation analysis is to sample the parameter space adequately and locate all of the minima within the parameter space. By definition, the parameter-space minimum that provides the best quantitative fit to the data, measured in terms of the smallest unweighted sum of squared errors (SSE), is the *global minimum* (assumed true solution), and the other minima are referred to as *local minima*. Local minima are effectively localized depressions in the parameter-space topography that trap the inverse regression algorithm during its attempt to find the global minimum – the smallest unweighted SSE. If multiple data types are included in the match, e.g., if pressures, pressure derivatives, etc., are matched simultaneously, then the weighted SSE values for each component are combined and the overall goodness-of-fit measure is denoted in nSIGHTS as the *fit value*.

Five hundred perturbation/optimization runs were performed for each of the analyses discussed in this report. A visual assessment of parameter-space plots for each fitting variable and a visual assessment of the fits themselves were all used to determine the value of the "fit discriminant". The fit discriminant is used to reduce the perturbations under consideration to only those within the best-fit minimum, and sufficiently close to be subjectively considered "acceptable" fits. All perturbation results for which the fit value was less than the fit discriminant were deemed acceptable solutions and are included in the final range of reported values for each fitting parameter. In some cases, the original baseline solution may not fall within the global minimum defined through perturbation analysis. The final number of satisfactory perturbation results for each test is reported in the Section 4 figure captions.

3. H-11b4R Analysis Results

Discussions of H-11b4R and associated test analyses are given below. A summary of the *T* estimates obtained from perturbation analysis of each test is shown in Table 1. The full range of *T* values from which the statistics in Table 1 are derived is presented as a scatter plot in the sections below and a full listing is contained within the nPost configuration file for each analysis.

Table 1. Culebra Transmissivity Estimates.

H-11b4R Test	Geometric Mean (m^2/s)	Log Geometric Mean (m^2/s)	Log Minimum (m^2/s)	Log Maximum (m^2/s)	Variance
Purge 1	7.45×10^{-5}	-	-	-	-
Purge 2	6.29×10^{-5}	-	-	-	-
2012 Pumping Test:					
T1(@ 46.58 m)*	3.25×10^{-5}	-4.488	-4.786	-4.389	1.67×10^{-13}
T2(@ 165.68 m)*	1.14×10^{-5}	-4.943	-5.196	-4.303	5.19×10^{-14}
Past Tests:					
H-11 pad avg. (1987)[1]	2.60×10^{-5}	-	-	-	-
H-11b4 (1988)[2]	4.50×10^{-5}	-	-	-	-
H-11b1 (1988)[2]	2.90×10^{-5}	-	-	-	-
H-11 pad avg. (1996)[3]	4.70×10^{-5}	-	-	-	-

*In cases where multiple transmissivities (typically called a Composite Model) were used to fit the data, each progressive *T* value was assigned a distance from the borehole.

[1] Saulnier (1987)
[2] Beauheim (1989)
[3] Beauheim and Ruskauff (1998)

3.1. H-11b4R

The Culebra interval of well H-11b4R was drilled between 11/1/2011 and 11/18/2011 (DOE 2013). The well was drilled to a depth of 755 ft with the Culebra interval screened from 720 ft to 746 ft. At the Culebra, the inner diameter (ID) of the well is 4.44-in and the pump is hanging on 3.18-in ID tubing. The siting and creation of the H-11b4R well was based on the need to replace the previous H-11b4 well. A physical description of the well is detailed in Figure 3.

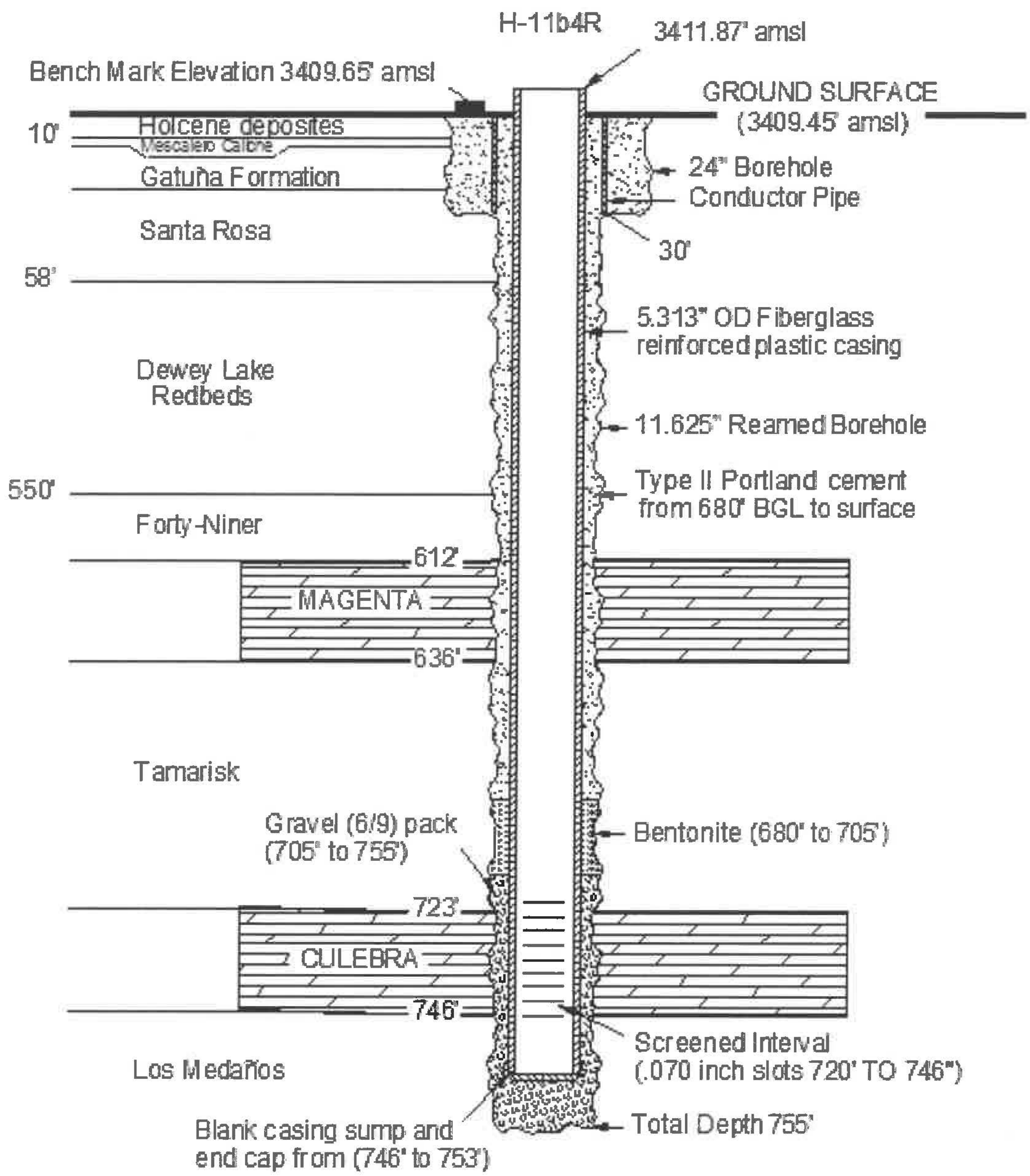
Two purge tests were initiated in the Culebra at H-11b4R on 4/24/12 and 5/8/12. Both purge tests concluded on the days they were initiated. These tests were analyzed to gain insight on the hydraulic parameters associated with the well to better frame the pumping rate and duration for the later 72-hour test. The simulations for the purge tests both consisted of a history period prior to drawdown, a drawdown period while purging was active, and a recovery period once purging concluded. The data and model used in each analysis are shown in Figures 4 and 5.

A 72-hour pumping test was initiated in the Culebra at H-11b4R from 6/11/12 to 6/14/12. The simulation of this pumping test consisted of a history period that extended partially after pumping began, a drawdown period, and a recovery period. The history period concluded after pumping started due to a generator malfunction approximately 3 hours into the test. The point at which the generator power was permanently established marked the beginning of the drawdown period. The recovery period simply began once pumping was stopped, but the period was concluded prior to full recovery due to changes in water level caused by a later test conducted at H-9bR. The data acquired for the test is shown in Figure 6.

The H-11b4R nSIGHTS simulation consisted of three sequences. The details of each sequence, i.e., start/end time, pressure, etc., are specified in the H-11b4R.nPre file and are listed in Appendix B.1.

The specified H-11b4R conceptual model, chosen because it was the simplest model consistent with the available information that produced an acceptable fit to the data, was an infinite-acting radial system with a variable *T* with respect to distance from the well, a negative skin and wellbore storage. Gravel pack around the well and localized Culebra fracturing due to drilling likely account for the negative skin. The *T* variations required for an adequate model were thought to be due to either a non-constant *T* in the system or double porosity effects. A variable *T* with respect to distance model was chose as the double porosity model did not provide as good of a fit as the for both the Cartesian form of the test data or the log-log diagnostic plots of the data. The range of *T* values derived from perturbation analysis is shown in Figure 7. The geometric mean *T* estimate derived from this analysis was 1.90×10^{-5} m^2/s. The Cartesian, log-log drawdown diagnostic, and log-log recovery diagnostic simulations corresponding to these *T* values are shown in Figures 9-11, respectively.

The *T* estimates gained through this analysis are similar to those of past tests and are compared in the preceding Table 1. Previously the wells had large positive skins (i.e., a low-permeability zone surrounding the well), which led to very high drawdown due to low pumping rates. Two large-scale tracer tests have been performed on the H-11 wellpad; summaries of hydraulic and tracer testing are found in Meigs et al. (2000), section E.6.



NOTE:

1. Depths in feet below ground level (BGL).
2. Not to scale.

Figure 3. H-11b4R well configuration during testing.

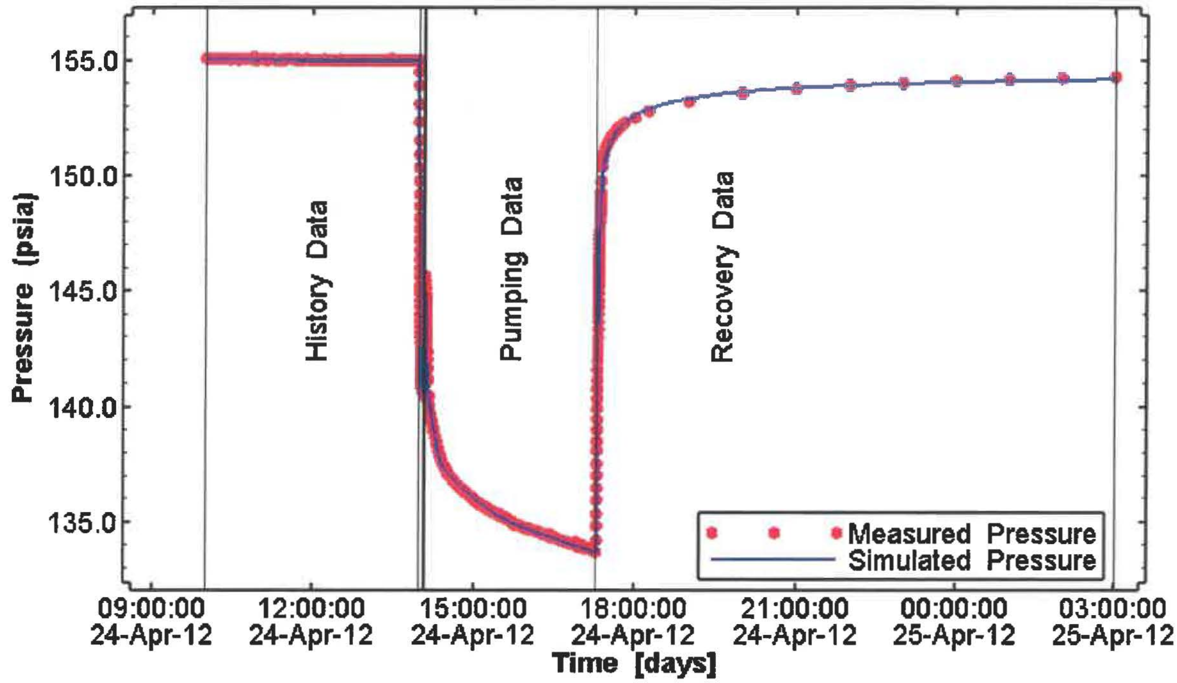


Figure 4. Pressure data from and model fit of the first Culebra purge test in H-11b4R.

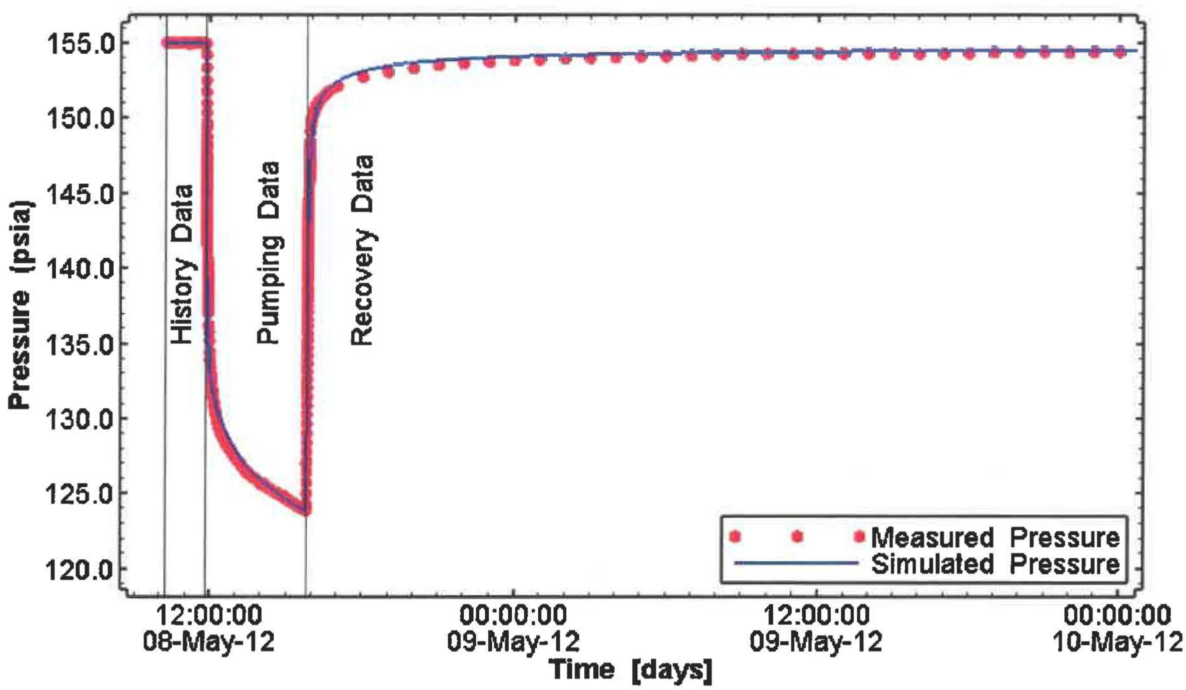


Figure 5. Pressure data from and model fit of the second Culebra purge test in H-11b4R.

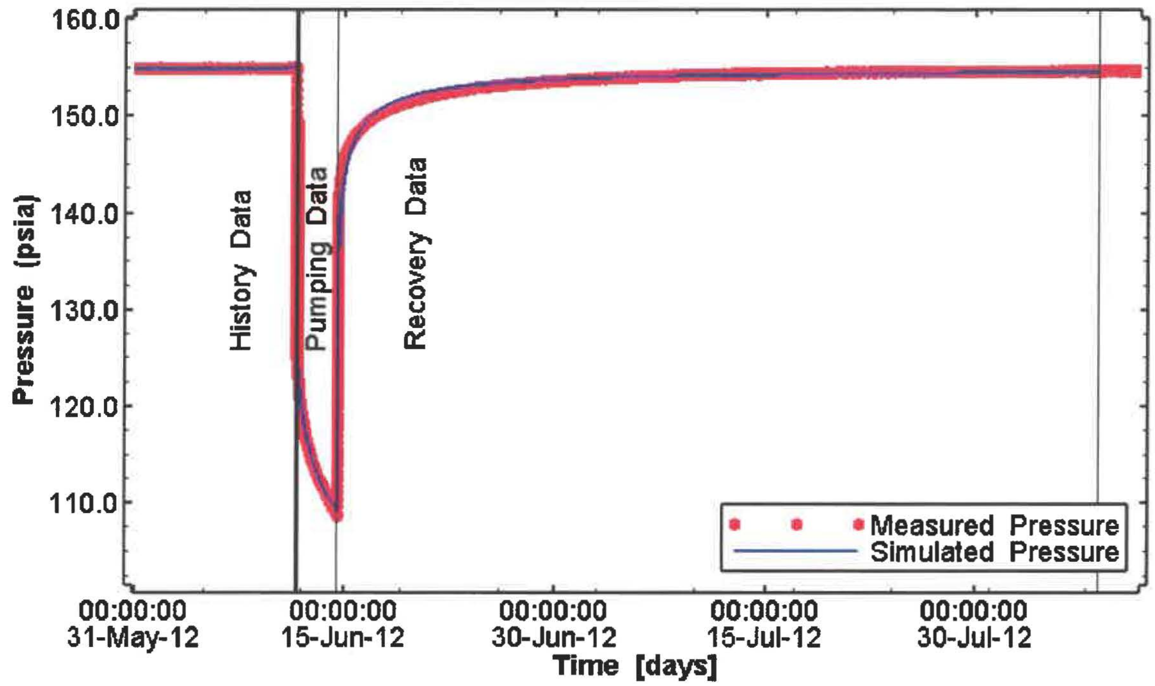


Figure 6. Pressure data from the Culebra pumping test in H-11b4R.

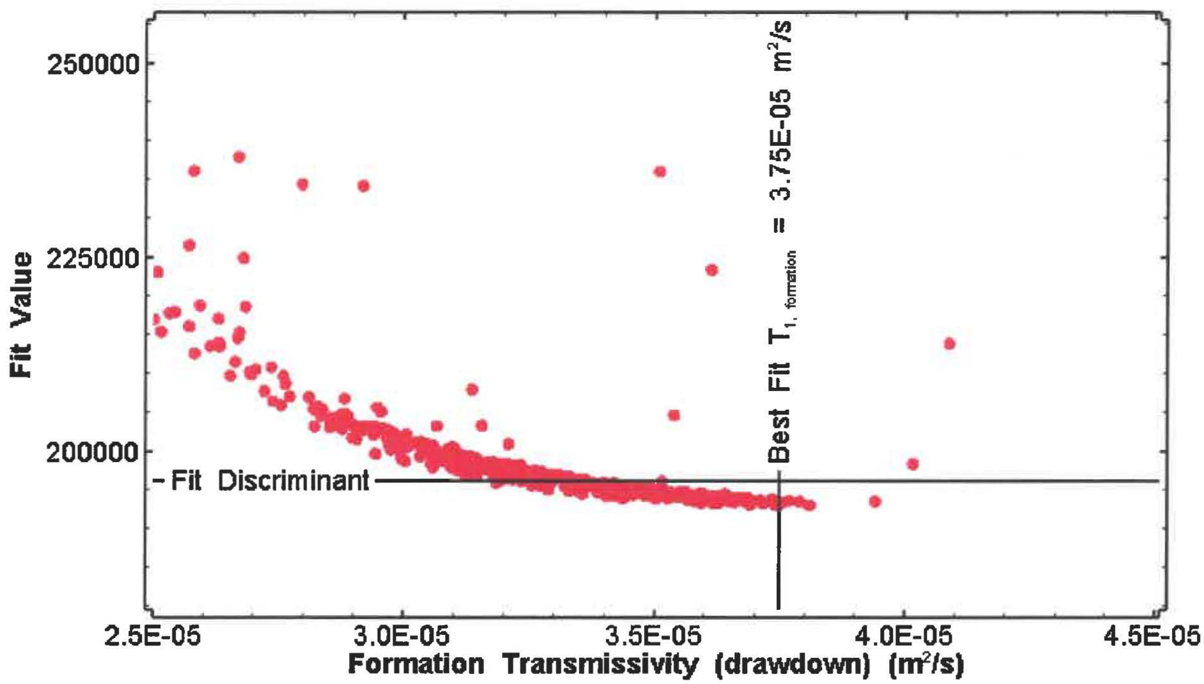


Figure 7. X-Y scatter plot showing the transmissivity parameter space derived from the H-11b4R perturbation analysis of the drawdown period along with the fit discriminant and best fit values.

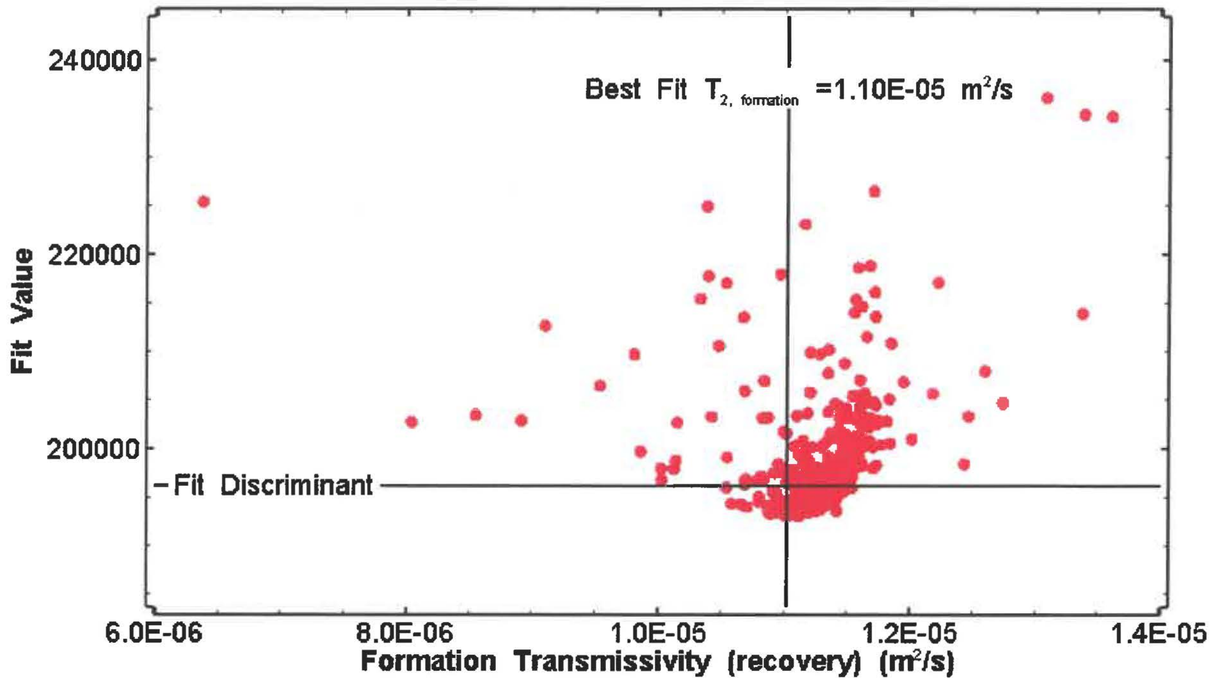


Figure 8. X-Y scatter plot showing the transmissivity parameter space derived from the H-11b4R perturbation analysis of the recovery period along with the fit discriminant and best fit values.

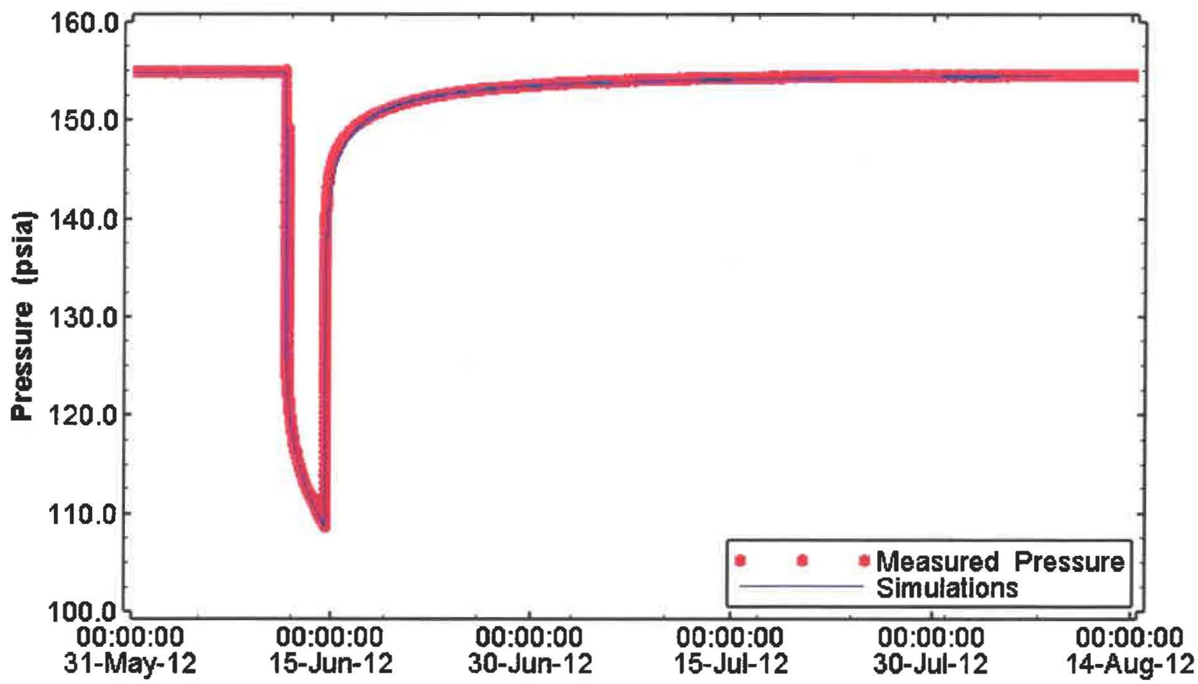


Figure 9. Linear plot showing 213 simulations of the H-11b4R pressure response.

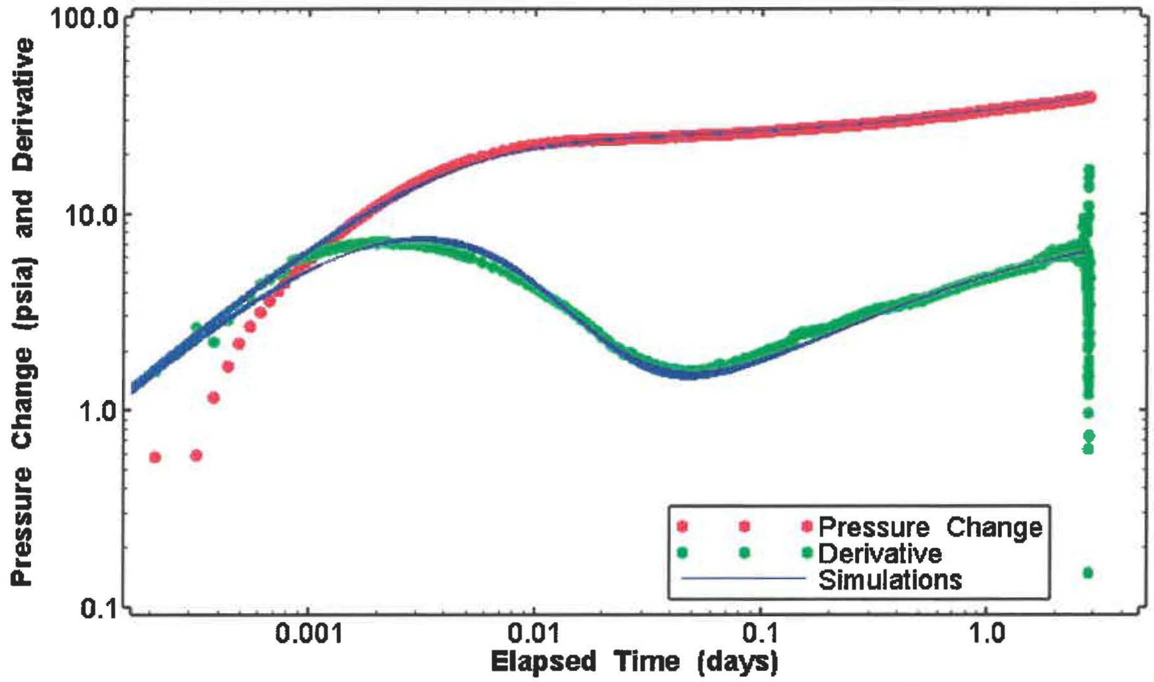


Figure 10. Log-log plot showing 213 simulations of the H-11b4R drawdown period pressure change and derivative response.

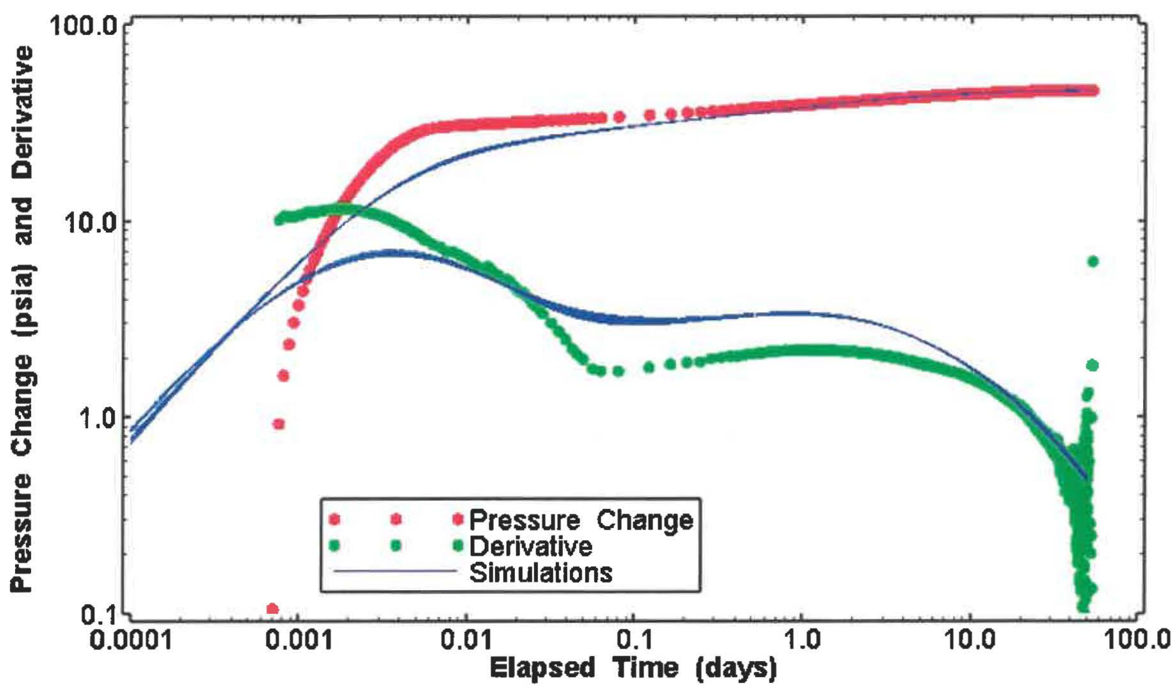


Figure 11. Log-log plot showing 213 simulations of the H-11b4R recovery period pressure change and derivative response.

4. References

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Appendix A – H-11b4R Hydraulic Test – 6/11/12 to 6/14/12

Well	Date and Time Start DAS	Date and Time Stop DAS	Date and Time Start Test	Date and Time Stop Test	Borehole Diameter (in)
H-11b4R	4/10/12 14:00	1/30/13 11:00	6/11/12 13:05	6/14/12 13:09	8.62

Inside Tubing or Casing Diameter (in)	Culebra Interval (ft bgs)	Fluid Density (g/cm^3)	Field Notebook	Data Source Report(s)
3.18	720 - 746	1.073	WSWT-15	BDR (C-2769-POD2)

Appendix B – nSIGHTS Listings

B.1 H-11b4R nSIGHTS Listings

```
*************
nPre/32 2.41a
*************

Version date    1 April 2011
Listing date    18 Aug 2013
QA status       QA: Approved
Config file     E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R\H-
11b4R_pumping_test_longhis.nPre
```

Control Settings

Main Settings

```
Simulation type                                  Optimization
Simulation subtype                                     Normal
Phase to simulate                                      Liquid
Skin zone ?                                               yes
External boundary                              Fixed Pressure
Curve data source                                     Objects
```

Liquid Phase Settings

```
Aquifer type                                         Confined
Aquifer horizontal permeability                     Isotropic
System porosity                                        Single
Compensate flow dimension geometry                        yes
Leakage                                                  None
```

Test Zone Settings

```
Test zone volume can vary                                  no
Test zone compressibility can vary                         no
Test zone temperature can vary                             no
Default test-zone temperature                           20.00     [C]
Solution variable                                    Pressure
Allow negative head/pressure                              yes
```

Parameters

Formation

```
Formation thickness                                    26.000     [ft]
Flow dimension                                            2.0     []
Static formation pressure                             155.000     [psi]
External boundary radius                              1000000     [m]
```

Formation conductivity	f(r) point	
Formation spec. storage	Optimization	
Minimum value	1.00000E-10	[1/m]
Maximum value	1.00000E-02	[1/m]
Estimate value	2.55938E-05	[1/m]
Range type	Log	
Sigma	1.00000E+00	

Skin

Radial thickness of skin	Optimization	
Minimum value	0.0001	[m]
Maximum value	10.0	[m]
Estimate value	0.0625197	[m]
Range type	Linear	
Sigma	1.00000E+00	
Skin zone conductivity	Optimization	
Minimum value	1.00000E-10	[m/sec]
Maximum value	1.00000E-01	[m/sec]
Estimate value	9.00661E-02	[m/sec]
Range type	Log	
Sigma	1.00000E+00	
Skin zone spec. storage	Optimization	
Minimum value	1.00000E-10	[1/m]
Maximum value	1.00000E-02	[1/m]
Estimate value	9.88313E-03	[1/m]
Range type	Log	
Sigma	1.00000E+00	

Fluid

Fluid density	1073.00	[kg/m^3]
Fluid thermal exp. coeff.	0.00000E+00	[1/C]

Test-Zone

Well radius	8.0	[in]
Tubing string radius	1.59	[in]

Numeric

# of radial nodes	250	[]
# of skin nodes	50	[]
Pressure solution tolerance	1.45038E-11	[psi]
STP flow solution tolerance	1.58503E-11	[USgpm]

f(x) Points Parameters

Formation conductivity

Points type	f(r)
Radius #1	Optimized

Minimum	10.0	[m]
Estimat	49.98674	[m]
Maximum	50.0	[m]
Y value#1	Optimized	
Radius #2	Optimized	
Minimum	50.001	[m]
Estimat	106.9158692	[m]
Maximum	500.0	[m]
Y value#2	Optimized	

X opt range type	Linear	
X opt sigma	1.00000E+00	
Y opt minimum value	1.00000E-10	[m/sec]
Y opt maximum value	1.00000E-02	[m/sec]
Y opt range type	Log	
Y opt sigma	1.00000E+00	
Parameter curve type	Linear	

Calculated Parameters

Formation

Transmissivity	f(r)	
Storativity	min/max	
Minimum	7.92480E-10	[]
Maximum	7.92480E-02	[]
Diffusivity	f(r)	

Skin Zone

Transmissivity	min/max	
Minimum	7.92480E-10	[m^2/sec]
Maximum	7.92480E-01	[m^2/sec]
Storativity	min/max	
Minimum	7.92480E-10	[]
Maximum	7.92480E-02	[]
Diffusivity	min/max	
Minimum	1.00000E-08	[m^2/sec]
Maximum	1.00000E+09	[m^2/sec]
Skin factor	f(r)	

Test Zone

Open hole well-bore storage	4.86979E-07	[m^3/Pa]

Grid Properties

Grid increment delta	min/max	
Minimum	0.05775	[]
Maximum	0.07743	[]
First grid increment	min/max	

Minimum	6.06612E-01	[m]
Maximum	1.63670E-02	[m]
Skin grid increment delta	min/max	
Minimum	0.00001	[]
Maximum	0.07992	[]
Skin first grid increment	min/max	
Minimum	2.04032E-06	[m]
Maximum	1.69072E-02	[m]
Skin last grid increment	min/max	
Minimum	2.04131E-06	[m]
Maximum	7.83742E-01	[m]
Increment ratio	min/max	
Minimum	7.73995E-01	[]
Maximum	8.01790E+03	[]

Sequences

Sequence: H_01

Sequence type	History	
Start time	41009.583330	[day]
Duration	61.961810	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Curve	
Wellbore storage	Open	

Sequence: H_02

Sequence type	History	
Start time	41071.545140	[day]
Duration	0.130562	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Curve	
Wellbore storage	Open	

Sequence: H_03

Sequence type	History	
Start time	41071.675701	[day]
Duration	0.001728	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Curve	
Wellbore storage	Open	

Sequence: H_04

Sequence type	History

Start time	41071.677430	[day]
Duration	0.001620	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Curve	
Wellbore storage	Open	

Sequence: H_05

Sequence type	History	
Start time	41071.679050	[day]
Duration	0.004019	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Curve	
Wellbore storage	Open	

Sequence: F_01

Sequence type	Flow	
Start time	41071.683069	[day]
Duration	2.861371	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Fixed	
Fixed value	-12.0	[USgpm]
Wellbore storage	Open	

Sequence: F_02

Sequence type	Flow	
Start time	41074.544440	[day]
Duration	54.330560	[day]
Time step type	Log	
First log step	1.15741E-07	[day]
# of time steps	250	
Type	Fixed	
Fixed value	0.0	[USgpm]
Wellbore storage	Open	

Test Zone Curves

Curve object to use	P_Curve
Curve type	Pressure
Start sequence	H_01
End sequence	H_05
Curve time base	Test
Curve Y data units	[psi]
Curve Y data is log 10	no

Simulation Results Setup

Output ID	DAT
Output type	Pressure
Pressure capture type	Test Zone
Output units	[psi]
Output ID	DAT
Output type	Flow Rate
Flow rate output type	Well
Output units	[USgpm]

Optimization Setup

Algorithm	Simplex
Simplex algorithm	NR
Calculate confidence limits ?	yes
Covariance matrix calculations	1st Order
Fixed derivative span ?	no
Fit tolerance	1.0000E-05
Parameter tolerance	not used
# of optimized variables	8
K_fm.R[01]	OK
K_fm.R[02]	OK
K_fm.V[01]	OK
K_fm.V[02]	OK
Skin zone conductivity	OK
Formation spec. storage	OK
Skin zone spec. storage	OK
Radial thickness of skin	OK

Fits to Optimize

CompositeFit	OK

Calculated Parameters Included

# of calculated variables included	0

Suite/Range Setup

# of suite/range variables	0

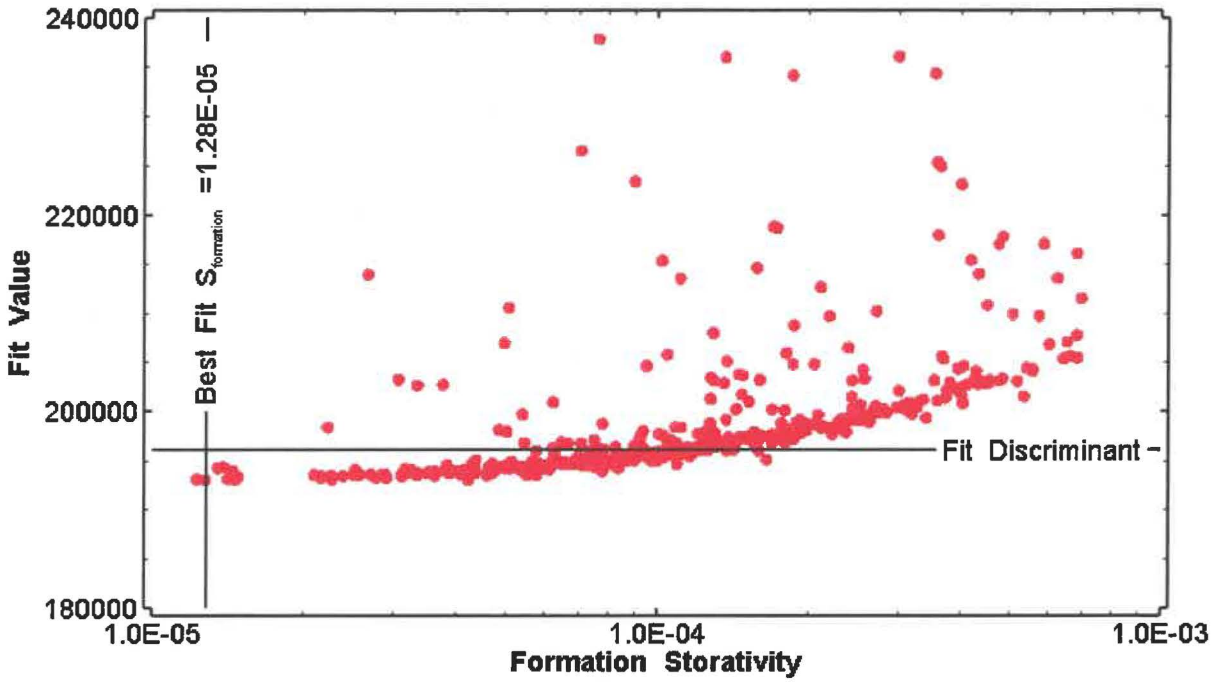


Figure B-1. X-Y scatter plot showing the storativity parameter space derived from the H-11b4R perturbation analysis with the fit discriminant and best fit values.

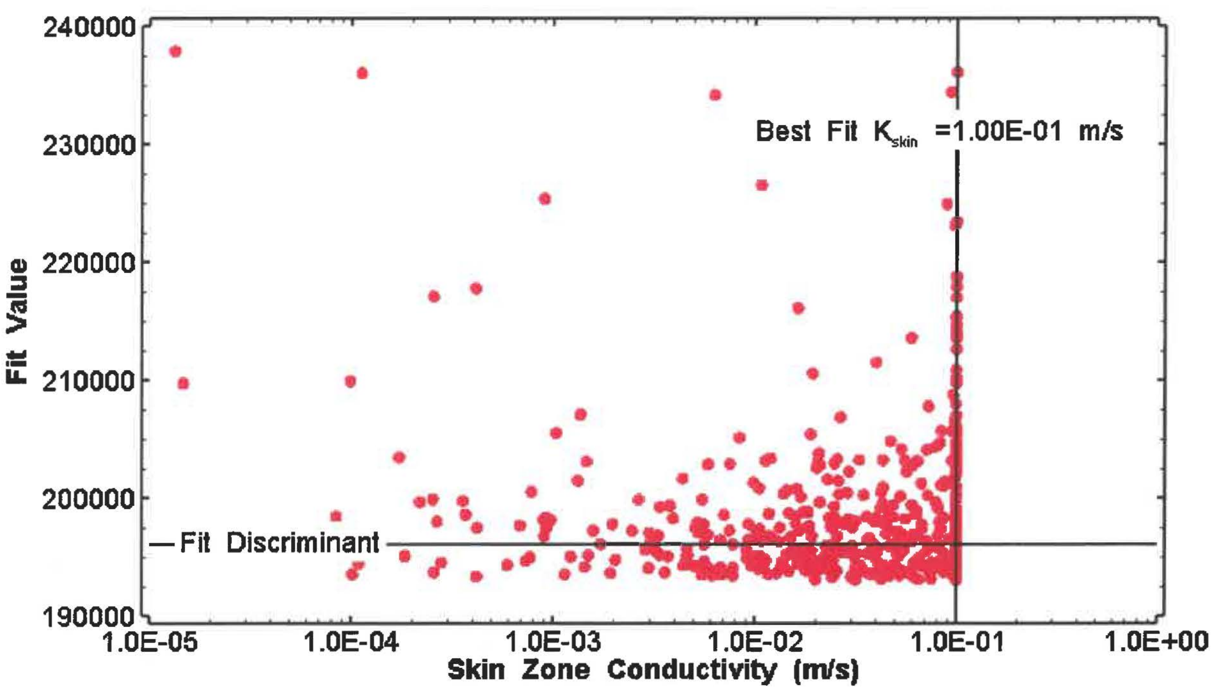


Figure B-2. X-Y scatter plot showing the skin conductivity parameter space derived from H-11b4R perturbation analysis with the fit discriminant and best fit values.

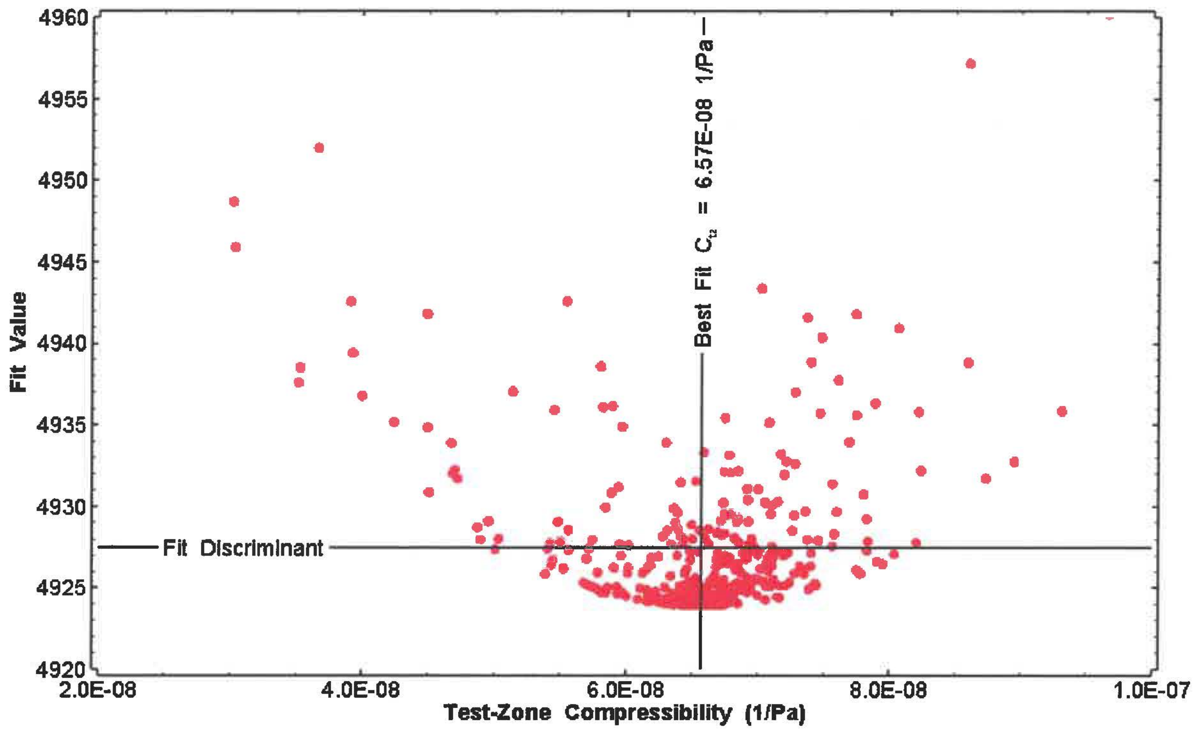


Figure B-3. X-Y scatter plot showing the skin zone specific storage parameter space derived from H-11b4R perturbation analysis with the fit discriminant and best fit values.

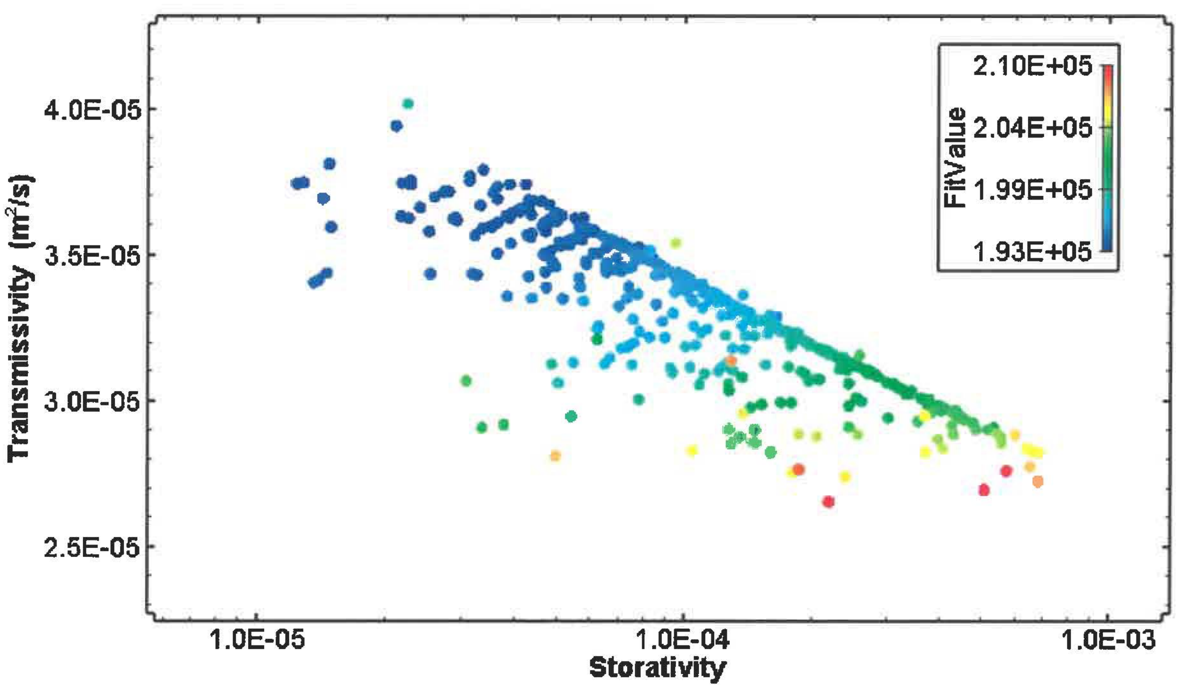


Figure B-4. Estimates of transmissivity (drawdown) and storativity derived from the H-11b4R perturbation analysis.

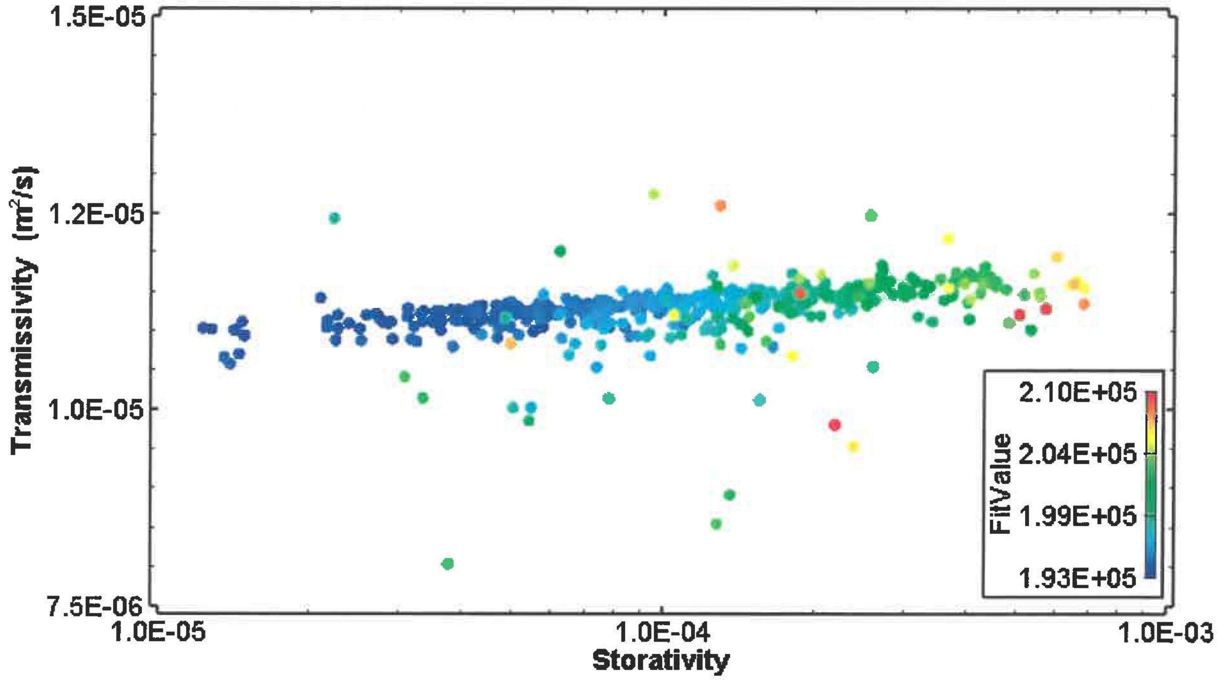


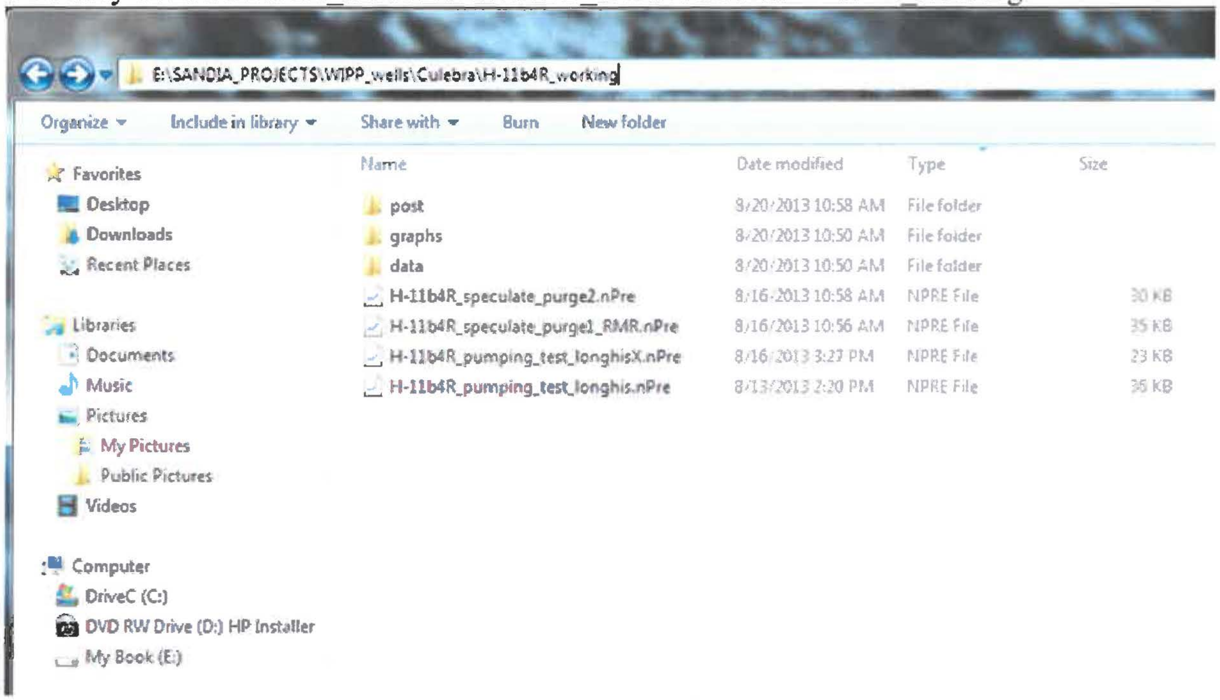
Figure B-5. Estimates of transmissivity (recovery) and storativity derived from the H-11b4R perturbation analysis.

Appendix C – File Directories

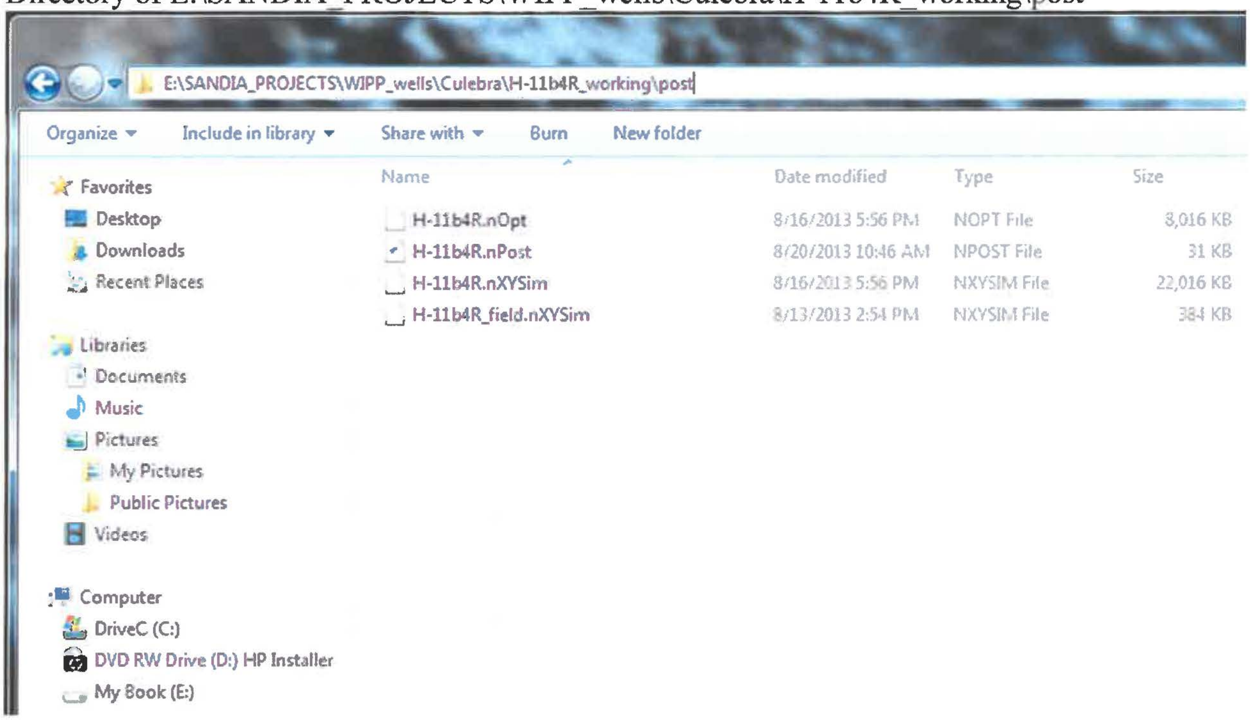
Table C-1. File descriptions.

File Extension	Function/Use
<filename>.nPre	Files used for initial well test analysis.
<filename>X.nPre	Files used to generate perturbation analysis of .nPre results.
.nPost	Post-processing files used to visualize .nPre and perturbation analysis.
.nOpt	Optimization data used for post processing in .nPost files.
<filename>.nXYSim	Simulation data used for post processing in .nPost files.
<filename>FieldData.nXYSim	Field data used for post processing in .nPost files.
.jpg	Graphic output from .nPost files.
.csv,.xls, .dat	Data files used as input for .nPre files.

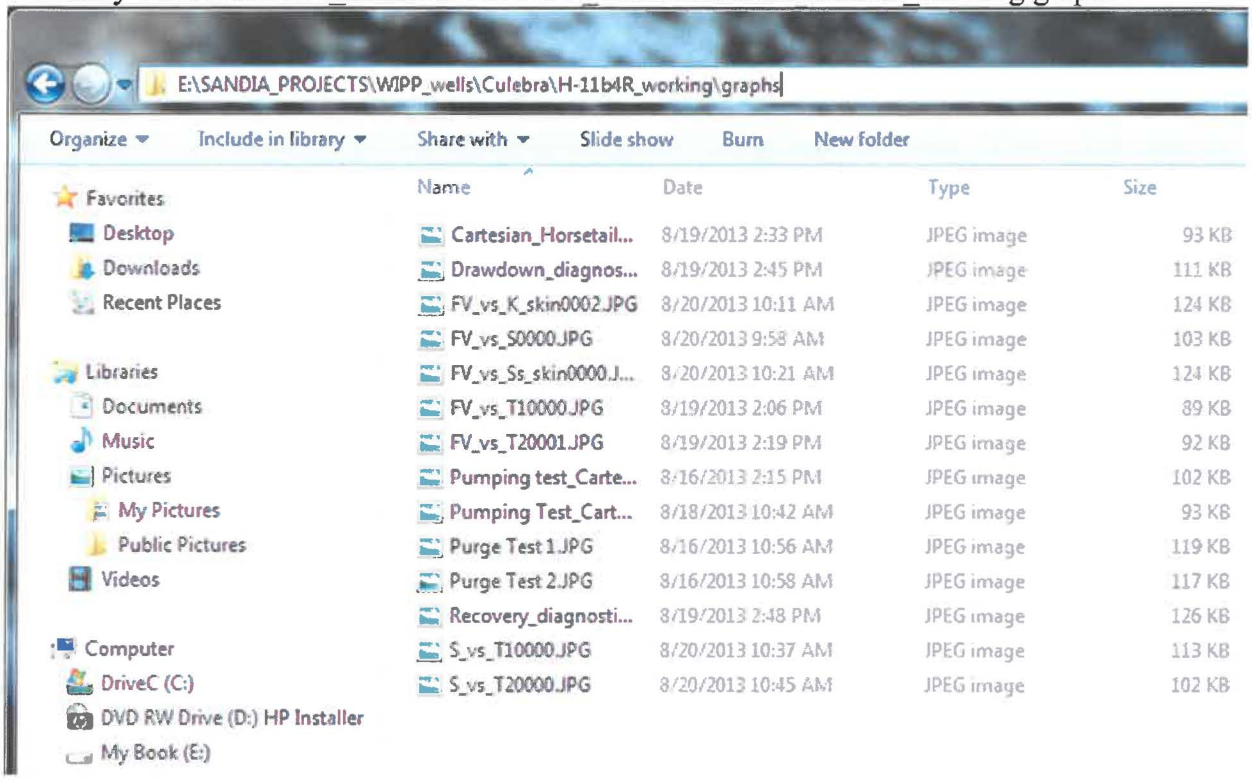
Directory of E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R_working



Directory of E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R_working\post

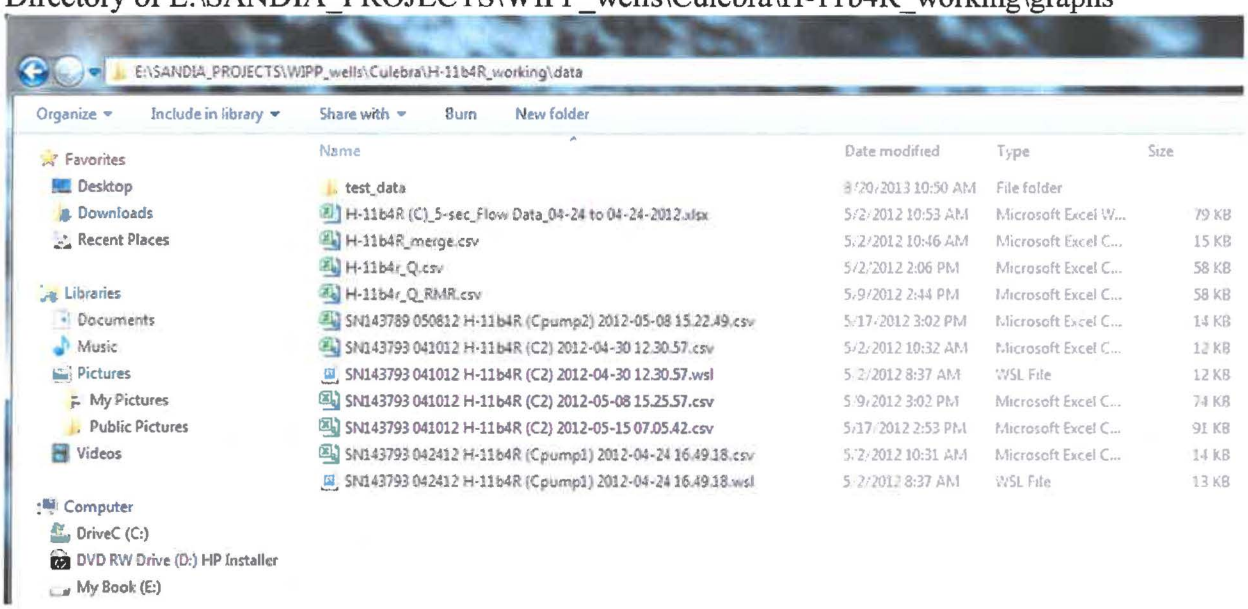


Directory of E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R_working\graphs



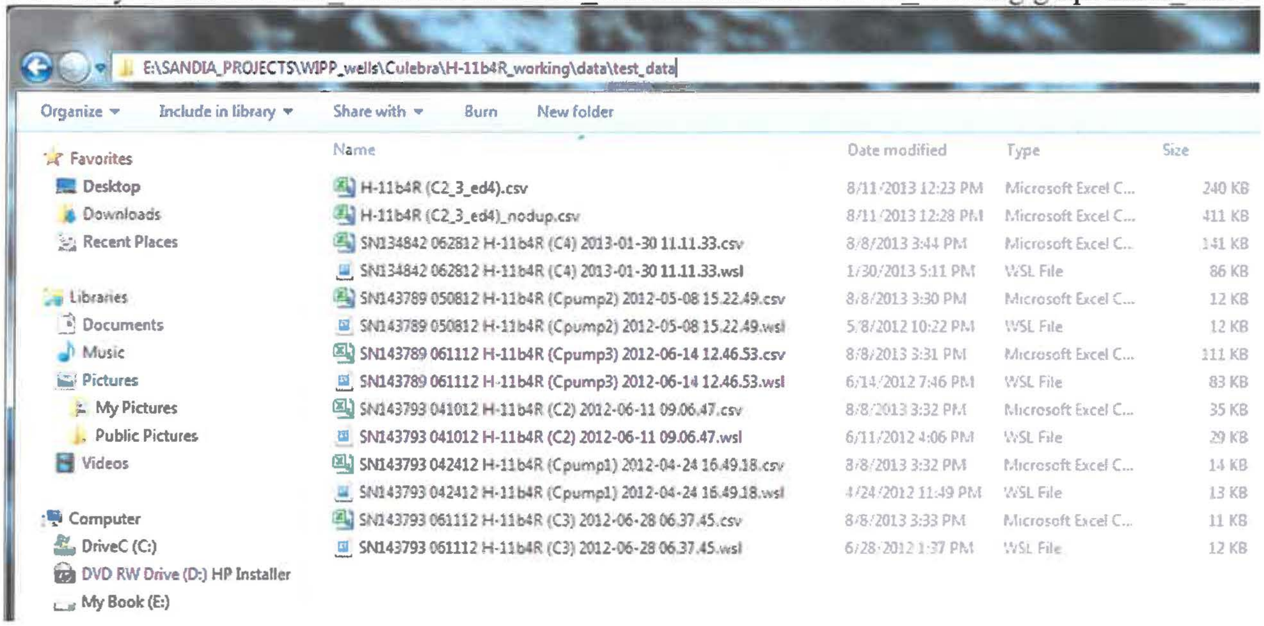
Name	Date	Type	Size
Cartesian_Horsetail...	8/19/2013 2:33 PM	JPEG image	93 KB
Drawdown_diagnos...	8/19/2013 2:45 PM	JPEG image	111 KB
FV_vs_K_skin0002.JPG	8/20/2013 10:11 AM	JPEG image	124 KB
FV_vs_S0000.JPG	8/20/2013 9:58 AM	JPEG image	103 KB
FV_vs_Ss_skin0000.J...	8/20/2013 10:21 AM	JPEG image	124 KB
FV_vs_T10000.JPG	8/19/2013 2:06 PM	JPEG image	89 KB
FV_vs_T20001.JPG	8/19/2013 2:19 PM	JPEG image	92 KB
Pumping test_Carte...	8/16/2013 2:15 PM	JPEG image	102 KB
Pumping Test_Cart...	8/18/2013 10:42 AM	JPEG image	93 KB
Purge Test 1.JPG	8/16/2013 10:56 AM	JPEG image	119 KB
Purge Test 2.JPG	8/16/2013 10:58 AM	JPEG image	117 KB
Recovery_diagnosti...	8/19/2013 2:48 PM	JPEG image	126 KB
S_vs_T10000.JPG	8/20/2013 10:37 AM	JPEG image	113 KB
S_vs_T20000.JPG	8/20/2013 10:45 AM	JPEG image	102 KB

Directory of E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R_working\graphs



Name	Date modified	Type	Size
test_data	8/20/2013 10:50 AM	File folder	
H-11b4R (C)_5-sec_Flow Data_04-24 to 04-24-2012.xlsx	5/2/2012 10:53 AM	Microsoft Excel W...	79 KB
H-11b4R_merge.csv	5/2/2012 10:46 AM	Microsoft Excel C...	15 KB
H-11b4r_Q.csv	5/2/2012 2:06 PM	Microsoft Excel C...	58 KB
H-11b4r_Q_RMR.csv	5/9/2012 2:44 PM	Microsoft Excel C...	58 KB
SN143789 050812 H-11b4R (Cpump2) 2012-05-08 15.22.49.csv	5/17/2012 3:02 PM	Microsoft Excel C...	14 KB
SN143793 041012 H-11b4R (C2) 2012-04-30 12.30.57.csv	5/2/2012 10:32 AM	Microsoft Excel C...	12 KB
SN143793 041012 H-11b4R (C2) 2012-04-30 12.30.57.wsl	5/2/2012 8:37 AM	WSL File	12 KB
SN143793 041012 H-11b4R (C2) 2012-05-08 15.25.57.csv	5/9/2012 3:02 PM	Microsoft Excel C...	74 KB
SN143793 041012 H-11b4R (C2) 2012-05-15 07.05.42.csv	5/17/2012 2:53 PM	Microsoft Excel C...	91 KB
SN143793 042412 H-11b4R (Cpump1) 2012-04-24 16.49.18.csv	5/2/2012 10:31 AM	Microsoft Excel C...	14 KB
SN143793 042412 H-11b4R (Cpump1) 2012-04-24 16.49.18.wsl	5/2/2012 8:37 AM	WSL File	13 KB

Directory of E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R_working\graphs\test_data



E:\SANDIA_PROJECTS\WIPP_wells\Culebra\H-11b4R_working\data\test_data

Name	Date modified	Type	Size
H-11b4R (C2_3_ed4).csv	8/11/2013 12:23 PM	Microsoft Excel C...	240 KB
H-11b4R (C2_3_ed4)_nodup.csv	8/11/2013 12:28 PM	Microsoft Excel C...	411 KB
SN134842 062812 H-11b4R (C4) 2013-01-30 11.11.33.csv	8/8/2013 3:44 PM	Microsoft Excel C...	141 KB
SN134842 062812 H-11b4R (C4) 2013-01-30 11.11.33.wsl	1/30/2013 5:11 PM	WSL File	86 KB
SN143789 050812 H-11b4R (Cpump2) 2012-05-08 15.22.49.csv	8/8/2013 3:30 PM	Microsoft Excel C...	12 KB
SN143789 050812 H-11b4R (Cpump2) 2012-05-08 15.22.49.wsl	5/8/2012 10:22 PM	WSL File	12 KB
SN143789 061112 H-11b4R (Cpump3) 2012-06-14 12.46.53.csv	8/8/2013 3:31 PM	Microsoft Excel C...	111 KB
SN143789 061112 H-11b4R (Cpump3) 2012-06-14 12.46.53.wsl	6/14/2012 7:46 PM	WSL File	83 KB
SN143793 041012 H-11b4R (C2) 2012-06-11 09.06.47.csv	8/8/2013 3:32 PM	Microsoft Excel C...	35 KB
SN143793 041012 H-11b4R (C2) 2012-06-11 09.06.47.wsl	6/11/2012 4:06 PM	WSL File	29 KB
SN143793 042412 H-11b4R (Cpump1) 2012-04-24 16.49.18.csv	8/8/2013 3:32 PM	Microsoft Excel C...	14 KB
SN143793 042412 H-11b4R (Cpump1) 2012-04-24 16.49.18.wsl	4/24/2012 11:49 PM	WSL File	13 KB
SN143793 061112 H-11b4R (C3) 2012-06-28 06.37.45.csv	8/8/2013 3:33 PM	Microsoft Excel C...	11 KB
SN143793 061112 H-11b4R (C3) 2012-06-28 06.37.45.wsl	6/28/2012 1:37 PM	WSL File	12 KB

Acknowledgements

The author of this report would like to acknowledge Jeff Palmer of Intera, Inc. for contributing the well configuration plot.